The kappa meson in lattice QCD

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The kappa (κ) meson is a I=1/2, $J^P=0^+$ scalar meson with strangeness. If the non-strange scalar meson sigma (σ), exists, it is natural to expect that the κ also exists. The existence of the σ has become plausible [1], and there have been many experimental and theoretical activities including lattice analyses[2]. Recently, two groups reported a candidate of the κ. In Ref.[3], a low mass scalar $K\pi$ resonance is reported. We, the SCALAR Collaboration, have started a lattice investigation to clarify whether this experimentally observed particle can be reproduced on the lattice.

We work with the operator $\bar{\psi}_s\psi_u$. The κ^+ propagator is then composed of u and $\bar{s}$ lines. We treat the s quark as a valence, while u and d quarks are dynamical. We employ Wilson fermions and the plaquette gauge action. We perform a full QCD simulation on $8^3 \times 16$ lattice by the hybrid Monte Carlo method.. We generate gauge configurations for three hopping parameter, $\kappa = 0.1846$, 0.1874 and 0.1891 at $\beta = 4.8$. These values are taken from Ref.[4] (CP-PACS). In Table 1, we show mass rations of π and ρ obtained here and from CP-PACS, together with the number of configurations used. In this measurement we determine the critical hopping value as κ_c=0.195(3). The lattice spacing determined from rho meson mass is a =0.207(9) fm.

For the s quark hopping parameter, we used 0.1835, 0.1840 and 0.1845. With these values, we calculate the *kappa* propagators on three sets of configurations with different u and d quark hopping parameters. In Table 2, we give the mass rations of κ and K^*. For each s quark hopping parameter, we extrapolate masses of K, K^* and κ mesons to the critical value of (u and d) hopping parameter. We conclude that for all three values of the s quark hopping parameter the κ meson mass is around twice that of K^* .

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References

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Table.1 π and ρ rations together with those from CP-PACS

κ	0.1846	0.1874	0.1891
statistics [1]	1510	1040	760
m_π/m_ρ [2]	0.8291(12)	0.7715(17)	0.7026(32)
m_π/m_ρ [3]	0.828(3)	0.766(4)	0.703(6)

[1] number of configurations, [2] CP-PACS, [3] our result

Table.2 Mass ratio m_κ/m_{K^*}

hopping parameter for u/d	hopping parameter for s		
	0.1835	0.1840	0.1845
0.1846	2.393(49)	2.403(50)	2.412(51)
0.1874	2.312(37)	2.315(38)	2.329(39)
0.1891	2.255(51)	2.262(52)	2.269(52)